Hermes

Efficient Metering Bus Networking
For communication in the world of smart metering, EBV Elektronik has launched the Hermes EBVchip, which sets entirely new standards in M-Bus communication. This new EBVchip is an upgrade of the IC which has serviced the market for the past 20 years; saving energy, reducing cost, offering a higher drive load and actively supporting a low-power mode, which is highly efficient, particularly for wireless M-Bus applications.

Recently, even people who are not technology-savvy have heard of smart metering, because they know that the intelligent use of energy can help us to use our planet’s limited resources more effectively and more responsibly. But a smart meter is only ‘smart’ if it communicates with the outside world.

The M-Bus (Meter-Bus) was designed around 25 years ago for exactly this type of communication. Although the committee involved originally designed the M-Bus for the remote reading of heat meters, the M-Bus has since come to be used for electricity, water, oil and gas meters as well.

The meters send their current consumption level via the M-Bus to an M-Bus master, a device that has, over the decades, become more than simply a central meter box and is now a data gateway that can communicate with users or with the energy supplier directly online. These data gateways with an integrated M-Bus master are today often known as MUC (Multi Utility Communication) boxes and metering concentrators.

Only if the M-Bus master actively addresses one of the energy meters designated as a slave will this slave send data on its current consumption level to the master via the M-Bus. Every meter has its own bus address for this purpose, which not only means that they can be uniquely assigned, but also that a specific slave (such as a water meter) only outputs its data on the M-Bus if the master explicitly requests this from precisely this slave (in this case the water meter). Because the M-Bus master supplies energy to the slaves via the two-wire M-Bus, the slave does not require its own energy source to communicate.

The principle of electricity modulation is employed for communication from the slave to the master. To signal a logical ‘1’, the slave draws a current of no more than 1.5 mA from the M-Bus. To transmit a logical ‘0’, the slave reduces its terminating resistance, thus increasing the current flow by 11 mA to 20 mA. Each individual slave therefore requires an idle current of 1.5 mA.

The master supplies the M-Bus with a nominal voltage of 36 V, while each slave draws a current of 1.5 mA from the M-Bus. Communication from the master to the slave takes place via voltage modulation, with the master reducing the bus voltage by 12 V to 24 V. A logical ‘1’ corresponds to the nominal voltage of 36 V, while a logical ‘0’ corresponds to a level reduced by 12 V. Since the nominal voltage may vary, particularly during communication from the slave to the master, it is not the absolute level (theoretically 24 V) that determines the logical status ‘0’, but the voltage difference of 12 V compared with the bus voltage when the level is logical ‘1’.

The MUC boxes specification on MUC boxes can be downloaded from the VDE (German Association for Electrical, Electronic & Information Technologies) at vde.com/de/fnn/arbeitsgebiete/messwesen/seiten/muc.aspx for use by manufacturers of meters and meter panels as well as users as an agreed working basis for developing communication modules.

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Communication takes place in both directions via a normal UART protocol with NRZ transmission and a useful data rate of 300 to 9,600 bit/s, usually at 1,200 bit/s. The master explicitly addresses the individual slaves one after the other, and each of the slaves then responds.

M-BUS has proven during the last 20 years to be reliable, flexible and has been adopted by main players in metering manufacturing.

HERMES

However, these 20 years have seen quite a lot of changes, both in terms of technology and the basic conditions. For this reason, EBV has now teamed-up with ON Semiconductor and developed the Hermes M-Bus Transceiver as an EBVchip that reduces power consumption offering significative advantages. Hermes meets the M-Bus specifications in full. The new EBVchip offers space reduction, lower cost and additional functions that enable a range of attractive new designs. This EBVchip employs a relatively complex mixed-signal design, which was developed by the former AMIS team within ON Semiconductor.

As with all EBVchips, this is an official chip from the respective manufacturer designed to the corresponding quality, although it is only available worldwide from EBV Elektronik.

Hermes is designed such that up to four programmable M-Bus loads can be connected. If required, you can even connect up to six M-Bus loads to a component, although this feature is not covered in the official M-Bus standard. The M-Bus loads can be programmed with the aid of an external resistor. At 38.4 kbit/s, the useful data rate of Hermes is also significantly higher than that of the well-established M-Bus component. To produce the new EBVchip, ON Semiconductor uses a tried-and-tested automotive process to safeguard supply over a long period of time.

Hermes is accommodated in a 4 mm x 4 mm housing of type QFN-20, thus saving a good 60% of the IC footprint compared with the previous solution, which was packaged in an SO-16. In addition, the classic transceiver can only drive a maximum of two M-Bus loads, which means that the slaves can only draw up to 3 mA per node. With higher power consumption levels, it used to be the case that two conventional M-Bus chips had to be installed in parallel so that four M-Bus loads could be used.

A SECOND SPRING FOR THE M-BUS

EBV Elektronik is anticipating the onset of a ‘second spring’ for the M-Bus, a market assessment based on the new, all-electronic electricity meters. A communication channel is normally also prepared in these meters so that a connection can be established to the energy supplier. This can be set up using Power line communication (PLC) via the energy grid itself, GPRS (mobile radio) or an Ethernet connection to the customer’s private Internet access.

Typical application in three-wire low power mode with bi-directional communication

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These types of intelligent energy meters – smart meters – typically also feature an M-Bus master so that the electricity meter can serve as the central point for the other energy meters: the other consumption meters, from the calorimetric meter to the water and gas meters, use the M-Bus to communicate with the electricity meter, which forwards the consumption data. This allows consumption readings to be taken in real time on the customer’s own PC and also recorded by the energy supplier immediately so that load-dependent tariffs can be applied.

NEW YET HIGHLY PRACTICAL CONCEPTS

More than 80% of non-electronic electricity meters can currently be easily connected with a cable to the M-Bus. A wired M-Bus solution is deployed whenever possible, because this means that the consumption meter is simultaneously supplied with energy. The system installation team switches to a radio link between the master and slave only if structural conditions do not allow a cable to be connected – despite the fact that laying M-Bus cables involves extra installation work.

This is due to the high maintenance requirements for the radio link, because a wireless connection requires the slave (meter) to have its own power supply (usually a battery) and, of course, these batteries need to be changed on a regular basis. However, the basic design should be such that energy meters can operate for 20 years without requiring any maintenance, which means that regular battery changes involve undesirable maintenance outlay, whereas a wired M-Bus is supplied with energy via the data cables.

In the fewer than 20% of the cases requiring radio transmission, a standard energy meter with a wired M-Bus connection, to which the installer can connect an additional M-Bus radio module, can still be used as a slave. This procedure is employed for purely logistical reasons because it means that only one meter type is needed.

For transmission via the radio link, the M-Bus protocol uses frequencies in the 868 MHz range. Details of this can be found in DIN EN 13757-4.

WIRELESS M-BUS: THE SLAVE SIDE

Supplying power to the M-Bus interface of a slave (gas/water/heat meter, etc.) from a radio battery involves a fairly high circuit outlay, because a relatively high level of electricity (around 20 mA) as well as a DC/DC booster would be necessary to transmit a small amount of data. The booster would increase the battery voltage (usually 3 V or 6 V, coming from two lithium cells) to the M-Bus voltage of 36 V. Since this method conflicts with the low-power approach and would require the batteries to be changed very frequently, this new application – which played no role when the M-Bus was defined more than 20 years ago – calls for alternative concepts.

Theoretically, the simplest solution is for additional contacts to the electricity supply of a radio module and contacts for the data connection to be integrated in the meter. To preclude manipulation, however, the meters are hermetically encapsulated, which means that every single contact made with the outside entails disproportionately high costs of around one dollar per contact. For this reason, as part of a compromise, a maximum of three contacts are possible: the two M-Bus contacts and, as a concession to the low-power operation, a third contact, which is only used beyond the M-Bus specification.
HERMES Optimised for the Wireless M-BUS

The new EBVchip is compatible with the M-Bus standard, and thus with old M-Bus products, but also offers many new features. For example, it conserves the batteries in an external HF module to an exceptional degree. The devices are therefore optimised for M-Buses, but can also operate the data link via radio if required. And this is precisely where the third contact of the Hermes comes in.

The three-wire interface is designed in such a way that when the system is switched on, it detects via the third contact whether any direct connection with the external battery module exists. In this case, communication does not take place via energy-intensive current modulation, but instead by means of a purely digital signal present on the contacts otherwise used by the M-Bus. This enables extremely energy-saving communication with the M-Bus master, which means that the battery in the slave module very rarely needs to be changed.

This third contact is connected to the OD pin on Hermes. Under normal circumstances, the sensor does not receive a supply current from the radio module. When the system is switched on, the chip checks whether the OD is high-resistance or connected via a pull-up resistor (‘OD’ here stands for ‘open drain’). The logical status ‘1’ is VDD, while logical ‘0’ is 0 V.

Half a second after being switched on, the sensor supplies its data to the HF module via the OD pin and then switches itself off again. This variant is used if only the reading is to be requested and no communication is required from the measurement data receiver downwards (in the direction of the meter). As soon as the meter registers that it is being supplied with energy on the M-Bus interface, it sends its current reading automatically.

If the energy meter connected via the radio module is also to receive data from the M-Bus master, however, bi-directional communication is required. Hermes also offers a suitable solution for this, enabling low-power operation.

As with the M-Bus, the HF module signals the data downwards through voltage modulation by switching the supply voltage on and off. However, while the M-Bus has at least 12 V, this is purely on-off keying, in which the power supply (which can be a maximum of 9 V) is switched on and off. The sensor must therefore also make sure that it has sufficient energy to send data and save enough energy in a capacitor for this purpose. During downwards communication, the sensor must also have sufficient energy and buffer this if necessary. This low-power method could also be used for updating software – although not with 36 V, but with the voltage from the radio module. The radio module power supply can be between 4.75 and 9 V; two 3 V lithium batteries are normally used in a system like this.

As in uni-directional low-power mode, communication from the slave to the radio module (which then transmits the data to the master) takes place with a purely digital signal via the OD output.

ADDITIONAL ELEMENTS IN HERMES

In the block diagram, all the elements that the EBV chip contains in addition to the well-established standard M-Bus chip are highlighted by green dashes. For example, Hermes features the aforementioned additional OD pin for the three-wire interface (shown in the top right). Three further pins are shown on the left side of the diagram.

The PMODE pin signals to the microcontroller – as purely a voltage monitor – which voltage is present. The MCU then switches to the relevant mode – either M-Bus mode or LP (low power) mode. This information is sent to the microcontroller and not used directly inside the EBVchip. With the aid of the PMODE pin, effective hot plugging is therefore possible without the M-Bus chip hanging.
Using the 2WLPM and 3WLPM pins (below left: 2/3-wire low-power), the microcontroller signals to the new EBVchip the mode in which it is to be operated. EBV Elektronik has deliberately removed the entire logic from Hermes to make sure that this chip is particularly robust and contains as little ‘intelligence’ as possible. A firmware upgrade for the microcontroller thus enables as yet unknown situations to be tackled and any faults to be eradicated via software. If chatter, very slow voltage rises or other phenomena impair the system, the developers can respond immediately with a software update. With this basic idea in mind, EBV Elektronik has deliberately opted not to develop a state machine in Hermes, which could be prone to faults, when designing this component.

Together with a leading customer, EBV will also draw up a reference design for the new EBVchip that will be complemented by the appropriate software.